U.S. Department of Agriculture Science and Education Administration
April 1981



# Agricultural Research



# Glenn Burton—The Scientist, *The Man*

Although the name "Glenn Burton" is not a household word, it probably should be, because few, if any, agricultural scientists have done so much for so many.

On February 18, 1981, Dr. Glenn Burton, SEA research geneticist at Tifton, Georgia, received the highest honor the federal government awards civilian employees—The President's Medal of Honor.

Breeding nutritious grasses to feed a hungry world has been Burton's job—and his avocation as well—for nearly half a century. **"I get tremendous satisfaction learning how people are using our grasses or millets to increase their food supply."**

Agricultural research, although less celebrated than some of the other research sciences, probably has more direct impact on more people. Glenn Burton has literally saved untold thousands of people from malnutrition or starvation around the world.

**"I would be remiss to think that what I have accomplished could have been done without my wife, my children, and friends who gave me love, understanding, and motivation—my bosses who provided support—my colleagues, support staff, and cooperators who supplied extra hands, ideas, and assistance—and the people at home and abroad who use our grasses and our research findings—they are the ones who made it all possible and very much worthwhile."**

Burton and a small research team of four fellow scientists today pursue a broad research program in plant genetics in grasses. Their research ranges from field selection to basic investigations of the fundamental nature of inheritance.

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**"I grew up alone on my father's farm in western Nebraska—an only child on a farm that was pretty much isolated. It would take a lot to make up for that opportunity to have my time alone to think. I started out very young doing chores and working with cattle, since the farm had livestock, as well as crops. I liked hard work. My day had succeeded in teaching me how to enjoy work. I think this is a tremendous debt I owe to him.**

**"I suppose the first interest I had in grass was at the county fair when I was 13 or 14 years old. There was a prize for a collection of native grasses. I made a collection and got the blue ribbon."**

After high school, Burton intended to remain on the farm with his father. However, his high school superintendant convinced him to attend the University of Nebraska and become a vocational agriculture teacher so that he could save money and buy his own farm. **"That was my only motivation for going to the university."**

He changed his vocational agriculture major to agronomy in the course of events at the university and was finally persuaded, with the help of a part-time job, to go on to Rutgers

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*Agricultural Research*
Vol. 29 No. 10
April 1981

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*Agricultural Research* is published monthly by the Science and Education Administration (SEA), U.S. Department of Agriculture, Washington, D.C. 20250. The Secretary of Agriculture has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Director of the Office of Management and Budget through June 15, 1982. Yearly subscription rate is $13 in the United States and its territories, $16.25 elsewhere. Single copies are $1.25 domestic, $1.60 foreign. Send subscription orders to Superintendent of Documents, Government Printing Office, Washington, D.C. 20402. Information in this magazine is public property and may be reprinted without permission. Prints of photos are available to mass media; please order by photo number.



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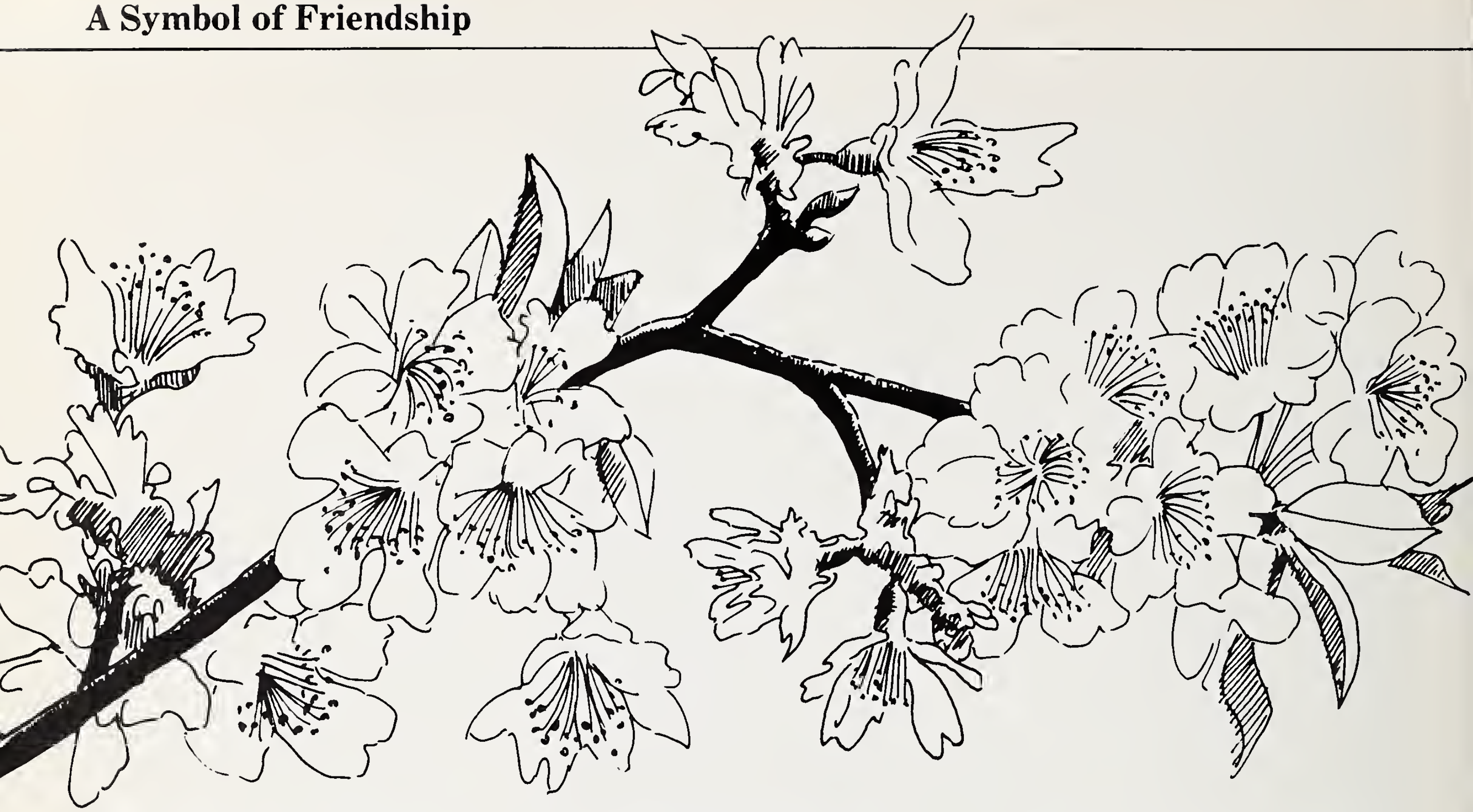
Cover: Flowering Japanese cherry trees have ushered spring into Washington, D.C., for 69 years, since Japan presented them as a gift of friendship to the United States in 1912. Now, the same varieties represented in Japan's gift are in danger of extinction in their native land, and U.S. scientists have offered their help in preserving them. Our stories begin on page 4 (DC-8).

# A Symbol of Friendship



The cultivation of "sato sakura," or "garden cherry," has been an exalted and integral part of Japanese culture for more than 1,500 years. Through the ages, the Japanese have equated the transient beauty of the cherry blossom with that of human life. Eliza Scidmore, a turn-of-the-century American writer who traveled extensively in Japan, wrote that except for Fuji-Yama and the moon "no other object has been theme and inspiration of so many millions of Japanese poems as the cherry blossom."

In the early 1900's, First Lady Helen Taft selected cherry trees to beautify the Tidal Basin and Potomac Park area, then known as the "Speedway." In April 1909, according to her instructions, the Superintendent of Public Buildings and Grounds purchased 90 double-flowering Japanese cherry trees from a Pennsylvania nursery and planted them along the Potomac River bank.

Soon after, Tokyo Mayor Yukio Ozaki learned of Mrs. Taft's interest in beautifying Washington with the flower of Japan, and offered 2,000 cherry trees as a gift of friendship from the people of Tokyo. The trees, from 10 of the better selections around Tokyo, were shipped to Seattle and transferred there to temperature-controlled railcars. They arrived in Washington, D.C., on January 6, 1910.

USDA officials inspected the trees for insect pests new to this country and other diseases. Unfortunately, they found serious insect infestations and root galls. As a safety precaution, the trees were burned.

Mayor Ozaki, understanding the importance of preventing the introduction of insects or diseases that might be detrimental to U.S. agriculture, offered to send another consignment of trees and to take the necessary steps to ensure their safe and healthy arrival.

In March 1912, 3,000 cherry trees arrived in Washington, D.C., pest and disease free. In a simple ceremony, Mrs. Taft planted the first of these cherry trees in West Potomac Park and Viscountess Chinda, wife of the Japanese Ambassador, planted the second. Most of the trees were then planted around the Tidal Basin and along Riverside Drive in East and West Potomac Park, which are under the care of the National Park Service.

On February 24, 1981, First Lady Nancy Reagan renewed this symbol of friendship by presenting a cherry tree to Japanese Ambassador Yoshio Okawara at the White House. The 3½-foot dormant tree was propagated by Roland M. Jefferson, SEA botanist, from the same tree presented to Mrs. Taft in 1912.

# The Japanese Cherry Tree—A Homeward Journey

During the 69 years since the United States first received 3,000 ornamental cherry trees as a gift from Japan, viewing the annual cherry blossoms has become a spring rite for thousands of visitors to the Nation's Capital.

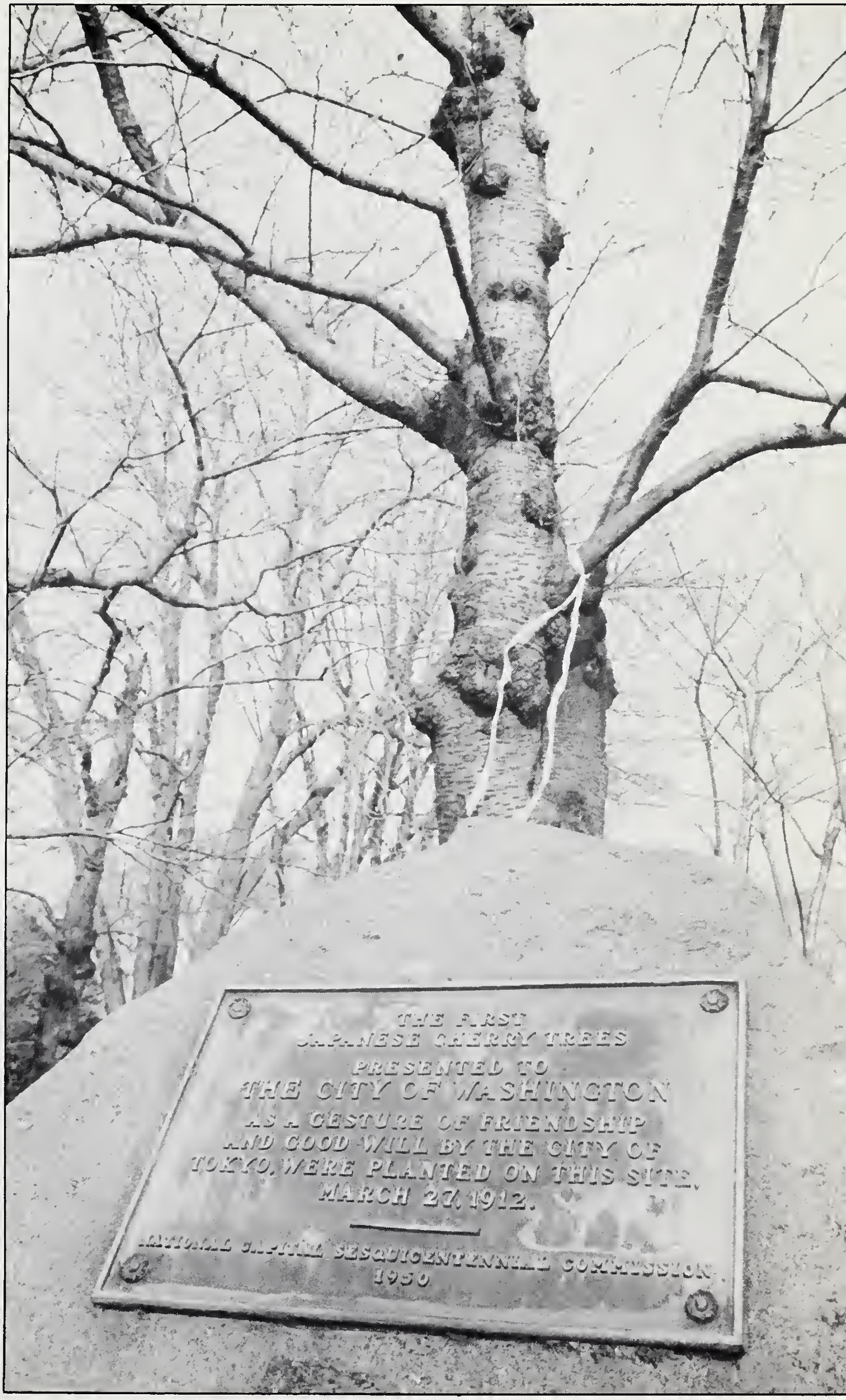
"And now the United States is returning Japan's favor," says Roland M. Jefferson, SEA botanist, who conducts research on the cherry trees at the U.S. National Arboretum.

In January 1981, representatives from the Tokyo Metropolitan Government's Park Section met with Arboretum and National Park Service officials in Washington, D.C., to collect approximately 2,000 cuttings from trees at Potomac Park and the Arboretum. Many varieties of the Japanese cherry trees that grace these Washington landmarks are no longer found in Japan because they have been lost to pollution and urbanization, says Takao Watanabe, chief of the park section, Adachi-Ku, Tokyo. Jefferson and C. James Lindsay, National Park Service horticulturist, worked with the Japanese visitors to gather and prepare the cuttings.

"The Japanese hope to re-establish the trees along the banks of the Arakawa River in the Kohoku area of Tokyo," says Jefferson. It was the Kohoku region that supplied Washington with its first 3,000 trees in 1912.

Arboretum scientists hope that current cooperation between the two countries will broaden into a long-term exchange and documentation of ornamental cherry tree material. Such an exchange is particularly important because the United States also has had difficulty in preserving certain varieties of the trees, says Jefferson.

Jefferson has begun to assemble and document what might become a national flowering cherry collection unmatched for its genetic diversity. To




Right: The cherry tree—symbol of friendship from Tokyo to the United States. The yellow ribbon—symbol of goodwill and faith from the American people to the 53 Americans formerly held hostage in Iran (181W063-3a).

Above: At the Tidal Basin, Takao Watanabe, chief of the park section, Adachi-Ku, Tokyo, prunes budwood for propagation from the same tree presented to First Lady Taft in 1912. Looking on are (from left): Yasuzi Suzuki, director of planning and then acting mayor, Adachi-Ku; Kiziro Kakuta, chairman of Adachi-Ku's citizen council, Ayase branch; and Roland M. Jefferson, SEA botanist at the U.S. Arboretum (181W063-37).

Watanabe narrows down propagation prospects (181W066-11).

date, more than 60 selections—including lost varieties that Jefferson has located in other parts of the country—are well established at the Arboretum. In previous research projects, he has also documented 182 cultivated crabapple species, varieties, and cultivars.

**Preservation Problems**

To maintain the unique characteristics of each hybrid, cultivated varieties of the Japanese flowering cherry must be propagated by layering, budding, grafting, or rooting—a task some horticulturists consider almost impossible for the large-flowered ornamental varieties that grow in Washington, D.C.

Budding is the most effective means of propagating the cherry. A vegetative bud—as opposed to a bud that produces flowers—is inserted beneath the bark of a healthy, compatible seedling called a rootstock.

A T-shaped incision is made in the bark of the stock about an inch above the soil level, and the bud is inserted and bound to the stock. This is usually

done in July and early August, during the height of the growing season. The following February, the rootstock is trimmed to within an inch above the grafted bud, which will grow into a 5- or 6-foot shoot, or "maiden," during the first growing season. The tree then can be trained to grow to the desired shape.

In addition to this difficult propagation process, the age of many trees in the United States hampers efforts to preserve the varieties they represent. Old trees are vulnerable to disease and storm damage. Of the 12 cultivated varieties in Japan's original gift, only two—Kwanzan and Yoshino—still grow along the Tidal Basin and Potomac Park shorelines.

**Journey to Japan**

In the continuing effort to preserve the flowering cherry in his country, Tadashi Furusho, mayor of Adachi-Ku, Tokyo, invited Jefferson to visit Japan. Jefferson arrived in Tokyo on April 4 and plans to study the tree in Japan for at least 1 month.

Starting at the southern end of Honshu, Japan's major island, Jefferson plans to follow the blooming cherries northward, looking for new superior wild plants and cultivated varieties. Jefferson says he hopes to incorporate measurements, photographs, and preserved specimens into a complete botanical description. He will also collect pollen and germplasm, in the form of budcuttings, for breeding purposes.

Because some trees will not bloom until after his visit, Jefferson will arrange for the Japanese to send him samples to complete his collection.

However, beautiful trees are not all Jefferson will search for. He also plans to collect samples of varieties valuable for disease resistance and cold hardiness. Much of this collection could come from wild, uncultivated cherries, Jefferson says.

During his trip, Jefferson plans to lecture throughout Japan. He has already prepared two presentations on cultivations of flowering cherries in the United States.

This trip, being paid for by the Japanese, will be the first of two phases in the effort to set up a research collection of cherry germplasm at the Arboretum. The second phase will take Jefferson, and perhaps other scientists, across the United States to collect about 30 varieties that exist in only one or two locations. He expects the Arboretum to grow two or three trees of each variety.

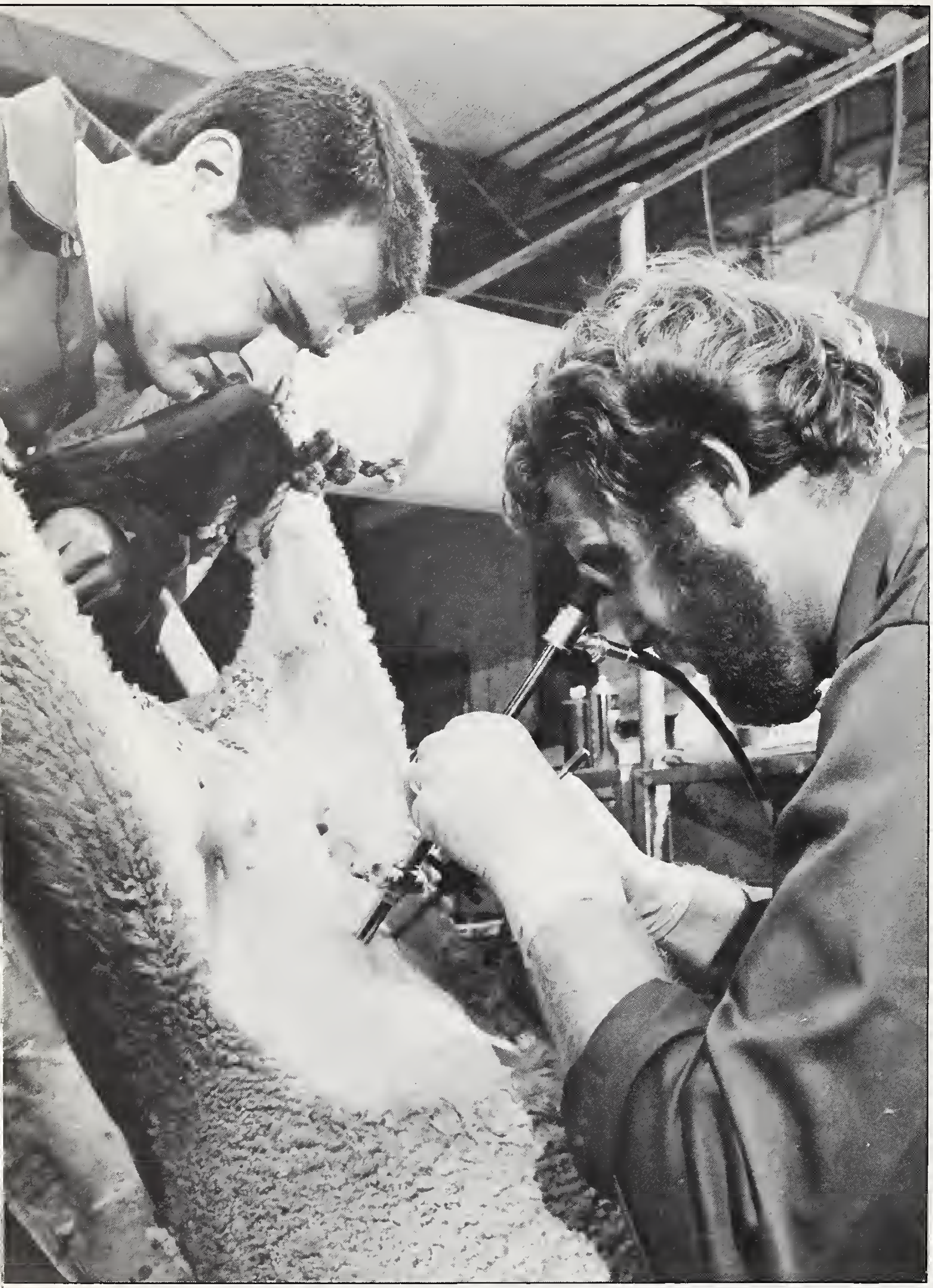
Jefferson plans to eventually publish a comprehensive worldwide catalogue of flowering cherries, documenting each selection's history, progeny, and location. Such a reference source could resolve the historical controversy that has surrounded the nomenclature of many cherry trees, and would identify those selections that are on the brink of extinction.

Roland Jefferson is located at the U.S. National Arboretum, 24th and R Streets N.E., Washington, D.C. 20002.—(By Andy Walker, SEA, Beltsville, Md., and Ellen Pomerantz, SEA Information, Washington, D.C.).

Top: After budwood is inspected, Marjorie Shorter (left), APHIS plant quarantine inspector, C. James Lindsay, National Park Service horticulturist, and Jefferson prepare budwood for packing and shipment to Japan (181W065-24).

Above: To prevent insects and disease from traveling to Japan along with budwood, Jefferson (left), and Walter Denny, APHIS plant quarantine inspector, ensure budwood's health (181W062-31).

# Sheep Composites—Parent Lines for Market Lamb Production



Above: Larry Young (left), research geneticist, and Neal Fogarty, graduate student, count the number of ovaries of pubertal ewe lamb with the laparoscopic technique—a method that allows researchers to inspect the ovaries with a lighted probe. Ovulation rate and age at puberty are evaluated as possible early selection criteria for improving reproductive rates of sheep (1080W1205-16a).

Profits from market lamb production can be increased substantially by using crossbred ewes of superior maternal breeds to produce lambs sired by rams of superior meat breeds.

Developing potentially superior breeds for use in such terminal crosses is the objective of SEA geneticists Lawrence D. Young and Kreg A. Leymaster at the Roman L. Hruska U.S. Meat Animal Research Center, Clay Center, Neb.

Young is directing development of maternal breeds and Leymaster development of paternal breeds. Each is determining the usefulness of multibreed populations, or "composites," as compared with the usefulness of the breeds forming these populations.

The researchers are giving priority to intensive or moderately intensive production of market lambs, for lambing either out of season or annually. Research on lamb and wool production under range conditions is underway at other federal and state research locations.

In development of maternal breeds, Young is taking advantage of genetic differences among breeds in such economically important traits as age at puberty, length of breeding season, and litter size. Ewes will come from this breed for the final cross.

Ewes are managed under two systems differing in labor and feed requirements.

One system calls for three lamb crops a year. These ewes are exposed to fertile rams in April, August, and December, giving each ewe an opportunity to lamb every 8 months. Young says that this intensive management system allows producers to more fully use confinement facilities and year-round farm labor.

The other system is conventional annual lambing, with ewes exposed to rams in November. Young says labor and available feed will continue to be seasonal in many areas, even for some producers willing to raise sheep in semiconfinement.

The flock for three-times-a-year

lambing, designated Composite I, is half Finnsheep, quarter Dorset, and quarter Rambouillet breeding. Young established Composite I by mating Finnsheep-Rambouillet crossbred ewes and rams to Finnsheep-Dorset ewes and rams.

The Composite II flock for annual lambing is half Finnsheep, quarter Suffolk, and quarter Targhee breeding. Mating Finnsheep-Suffolk crossbred ewes and rams to Finnsheep-Targhee crossbred ewes and rams established Composite II.

Selection emphasis while upgrading the two flocks will be somewhat different.

In Composite I, improving out-of-season breeding will have priority; in Composite II, increasing the number of lambs produced per ewe each year will have priority. Earlier age at puberty, better mothering ability, and larger litter size are additional selection objectives in both composites. The breeds forming each composite will be similarly selected for comparison.

In his part of the study, Leymaster is working with both a Suffolk flock and a three-breed composite population. The paternal breeds he is developing are potential sources of rams for sheep producers specializing in market lamb production.

In previous research at the Center, the Suffolk breed excelled in lean growth rate as compared with the Hampshire, Dorset, Rambouillet, Targhee, and Corriedale breeds. The Clay Center scientists also found that Suffolks were superior to Hampshires and Oxfords as terminal sires of market lambs.

Leymaster is developing selection procedures for paternal breeds in the Suffolk flock. His major emphasis is on producing market lambs with more efficient lean growth up to relatively heavy weights.

The three-breed paternal composite is based on a crossbred foundation established by mating selected Columbia rams to Suffolk-Hampshire crossbred ewes. The resulting composite is half Columbia, quarter Suffolk, and quarter Hampshire.

This composite population will be placed in a selection program for improving efficiency of lean growth.

This long-term breeding and selection effort should produce information useful to producers of purebred and commercial stock.

Results of these studies should be especially useful to those producers who wish to apply genetic principles in improving market lamb production under intensive or semi-intensive management.

Selection methods developed by Young and Leymaster for upgrading sheep populations as sources of ewes or rams will aid producers in establishing their own breed improvement programs.

Drs. Lawrence D. Young and Kreg A. Leymaster are located at the Roman L. Hruska U.S. Meat Animal Research Center, P.O. Box 166, Clay Center, NE 68933.—(By Walter Martin, SEA, Peoria, Ill.)

Top: Scanogram equipment operated by Mike MacNeil (left), statistical consultant, and Kreg Leymaster, research geneticist, incorporate ultrasonic scanning techniques to photograph an interior cross section of a sheep. Fat thickness and muscle area can then be measured to aid in selecting genetically superior animals (1080X1206-15).

Above: Maternal breed development of ewes can improve market lamb production by promoting increased litter size or additional litters each year (1080X1204-8a).

# Build a Backyard Solar Food Dryer

Top: An inexpensive, easy-to-build solar fruit and vegetable dryer, demonstrated by Charles J. Wagner (left), SEA chemical engineer, and Richard L. Coleman, SEA research chemist, uses curved aluminum foil mirror to reflect enough solar energy to dry produce 2 or 3 times faster than conventional sun-drying (880X1042-30a).

Above: Sliced plantains, peppers, carrots, peaches, and celery are all candidates for low-cost home drying. Dried products shown below can be stored in containers at room temperature (880-1042-4).

If you love the tangy, sweet taste of dried apricots and peaches, or enjoy the spicy flavor of dried peppers and onions, a backyard solar food dryer may be just the thing for you.

For less than $20, you can build this energy-efficient device. All you need for the project are simple handtools—hammer, drill, pliers, clamps, and handsaw; inexpensive materials—string, aluminum foil, glue, and wood for a frame; and a little bit of do-it-yourself ingenuity.

Free, detailed instructions are available from the U.S. Citrus and Subtropical Products Laboratory in Winter Haven, Fla., where SEA researchers designed, built, and tested the dryer as part of a cooperative effort with the Department of Energy.

The unique feature of the dryer is a low-cost, curved focusing surface that concentrates radiation from the sun just enough to dry foods but not enough to cause them to overheat or burn. The focusing surface is made from ordinary household aluminum foil drawn over strings held taut by a framework of laminted wood curves or parabolas. These parabolas are glued into a framework designed to support the dryer at an angle that best catches the sun's rays. The dryer focuses 16 sq. ft. of insolation—incoming solar radiation—onto 5.3 sq. ft. of drying surface.

The dryer is covered with polyethylene (clear plastic) with slit openings arranged at the top and bottom to allow controlled air to flow upward from the base, through a perforated aluminum shelf on which the food is dried, and then out the top. This plastic covering protects the food from dust, birds, insects, rain, and prevents the re-entry of moisture.

Chemical engineer Charles J. Wagner and research chemist Richard L. Coleman (project leader) have simplified what might have been a difficult phase of the construction by forming the parabolic curves with thin wooden strips placed according to pattern, then glued and secured with clamps.

"The parabolic aluminum reflector increases the drying rate of foods," says chemist Robert E. Berry, laboratory director. "Some products that previously took 3 to 5 days for solar drying can be dried in 1 to 1½ days. With this model, we have beaten the high cost of previous designs which used parabolic solar-concentrating mirrors."

"Parabolic reflectors have been used as solar energy focusing devices throughout history," says Coleman. "Now, as the cost of fossil fuels continues to climb, the application of solar energy is not only popular, but necessary."

The researchers have evaluated sun-drying of tropical and subtropical fruits and vegetables for several years. Wagner has found that peaches, mangos, green peppers, onions, mushrooms, plantains, and grapes can be successfully preserved by home drying. Some food products need pretreatment, such as blanching and/or slicing.

Coleman and Wagner have also studied the effect of focused insolation on moisture content of muscadine grape varieties, which make excellent raisins. The researchers expect to find some differences in drying times between fresh, deseeded, and pretreated grapes.

Information on pretreatment for sun-drying foods is available from the researchers, along with detailed, illustrated directions on the construction of the solar dryer. Write to the U.S. Citrus and Subtropical Products Laboratory, P.O. Box 1909, Winter Haven, FL 33880.—(By Peggy Goodin, SEA, New Orleans, La.)

# Tiny Wasps—Key Insect in Biological Control

Enthusiasts for biological control of insects take note—success appears near at hand to researchers who are developing more economical techniques to rear millions of tiny parasitic wasps called *Trichogramma.* The wasps are so tiny that 10 could easily sit on the head of a pin.

Success depends on improving the attractiveness of sites into which the diminutive wasps oviposit, or lay their eggs, and improving the diet that hatched larvae need to develop into fertile adults.

*Trichogramma* are endoparasites. That means they oviposit into eggs of a host insect. Then *Trichogramma* offspring develop from these eggs after killing the host and its offspring, explains SEA entomologist J. David Hoffman of the Biological Control of Insects Research Unit, Columbia, Mo.

In nature, *Trichogramma* attack the eggs of many key pests of row crops, forests, and home gardens. And Hoffman says the wasps would be more effective than they now are if there were more of them in the proper place at the proper time. In forests infested with spruce budworms, for example, he perceives a need for aerial drops of millions of these wasps.

Commercially available *Trichogramma* now retail for 20 to 40 cents per thousand. When released one to three times a week throughout the growing season, 50,000 to 70,000 of the parasites would be needed per application to control larval pests in a 1-acre tomato truck garden, Hoffman says.

What makes this researcher so hopeful? He envisions technology that will lower the cost of producing the wasps.

Until now, more than 90 percent of the cost of rearing *Trichogramma* in the United States has been the expense of rearing Angoumois grain moths—the easiest hosts to supply. And much of the expense usually relates to problems in host rearing.

But rearing *Trichogramma* without the host egg now appears feasible, says Hoffman. The SEA scientist has induced the wasps to oviposit into artificial eggs that he designed. He formulated nutrients that sustained the larvae and put them into artificial eggs. Some of the larvae developed into fertile adult wasps.

Now, Hoffman is trying to perfect the design of the artificial eggs and the diet media they contain. Then he plans to establish a small continuous colony of the wasps without using host eggs. The cost of producing the wasps could then drop to less than 1 cent per thousand. If *Trichogramma* can be reared artificially, mass releases may be economically feasible in the United States.

Hoffman says that *Trichogramma* could become one of the most useful biological control agents in the world if they can be reared in sufficient numbers at costs that are competitive with costs of other control agents.

In the United States, economic considerations apparently have not favored mass rearing and release of *Trichogramma,* Hoffman says. Large facilities for rearing the Angoumois grain moths or other hosts must be designed to provide an ideal environment—and must be kept free of mites and disease organisms. Added to this is the cost of handling the moths and wasps.

When the need for rearing moth hosts is eliminated, mass release of *Trichogramma* may take a prominent role in biologically controlling destructive insects. Hoffman says that if these wasps can be reared economically, they can become one of the most useful insects in the world because they attack primary caterpillar pests on a wide variety of food and fiber crops.

Mass releases should also improve control of secondary insect pests. The chemical insecticides presently directed at primary pests often kill many natural enemies of secondary pests. (By Ben Hardin, SEA, Peoria, Ill.)

# Seeking Improved Nitrogen Fixation in Soybeans

Above: Possible nitrate reductase mutants selected at the seedling stage are grown to maturity, harvested, and the next generation of seedlings are further tested by James Harper, SEA plant physiologist, for low nitrate reductase activity (280W181-13a).

Right: Sarah Ryan, research associate from Australia, inspects soybean seedlings for mutants having possible low nitrate reductase enzyme activity. Mutants identified as having low amounts of this enzyme are selected for further breeding experiments. Scientists are hopeful that low amounts of nitrate reductase enzyme—which helps convert soil nitrate for plant use—could force plants to use more nitrogen from the atmosphere, thus conserving soil nitrogen. (280W182-30).

Scientists are screening mutant soybean plants for plants that in nitrate-rich media derive more nitrogen from the air than do presently grown varieties.

SEA plant physiologist James E. Harper, and his colleagues at the University of Illinois, Urbana, estimate that soybean varieties presently grown in the Midwest obtain only 25 to 50 percent of their nitrogen from the air. Soybeans remove as much additional nitrogen from the soil as does corn—one of the heaviest nitrogen-using crops.

Soybeans, and other legumes, remove nitrogen from the air by a process called symbiotic nitrogen fixation. Certain bacteria invade the roots of the plants and cause swellings, called nodules, where nitrogen gas from the air is converted, or fixed, to an ammonia form that the plants can use.

Increasing soybeans' use of symbiotically fixed nitrogen and decreasing their use of soil nitrogen is seen as a way to conserve soil nitrogen for corn crops which often follow soybeans in the same field the next year.

In the leading eight soybean-producing states, Harper estimates that increasing symbiotic nitrogen fixation by 60 pounds per acre would add up to about 1 million tons of nitrogen. The natural gas energy used to produce that much nitrogen fertilizer equals the energy in about 7.4 million barrels of crude oil—more than a day's imports by this country.

Harper's research could eventually lead to new soybean varieties that exceed the current varieties in symbiotic fixation by even more than 60 pounds of nitrogen per acre on soils already rich in nitrogen.

The mutants he is seeking are soybeans lacking or containing smaller than normal amounts of an active enzyme, nitrate reductase, that plays a role in converting nitrate into the form of nitrogen that plants can use. "Nitrate reductase is needed to produce high yields," Harper says, "and soil nitrogen consists mostly of nitrate."

He speculates that nitrate may indirectly inhibit development of root nodules needed for symbiotic nitrogen fixation. The indirect link may involve nitrate reductase. The researchers have succeeded in getting soybean roots to develop functioning nodules in a nitrate-rich growth medium by adding tungstate to the medium. Tungstate inactivates nitrate reductase.

Now, Harper is screening soybean mutants for low nitrate reductase activity. If the researcher finds the mutants he's looking for he will test them for their ability to fix nitrogen in a nitrate-rich medium.

Looking into the future, scientists may be able to incorporate the low-nitrate-reductase trait into soybean breeding lines. This process would involve several years of field testing.

Dr. James E. Harper is located at Turner Hall, Agronomy Dept., University of Illinois, Urbana, IL 61801.—(By Ben Hardin, SEA, Peoria, Ill.)

# Computer Simulates Wheat Straw Decomposition

A computer model designed to predict what will happen to nitrogen and carbon during straw decomposition has been developed by a team of SEA researchers led by microbiologist Lloyd F. Elliott at Washington State University, Pullman.

To develop the model, the scientists traced the effects of nitrogen and carbon on the life cycles of microorganisms in decomposing straw. The mathematical description of the process represents the first step in understanding the interrelationships of nitrogen, carbon, and wheat straw decomposition.

Wheat-growing areas in the Pacific Northwest are suffering severe erosion problems, primarily because traditional tillage completely turns over the soil after harvest. To cut the terrible soil losses (and conserve energy), reduced tillage practices are needed.

Under reduced tillage, wheat straw is left to decompose on the soil surface. Researchers don't know how much soil nitrogen is tied up by the decomposition process and unavailable to crops. Elliott hopes that the new mathematical model will clear up some of the confusion.

"If nitrogen fertilizer is placed properly with surface-managed crop residues," he says, "the potential for nitrogen tie-up will be less than when the residues are incorporated."

"In the laboratory, we found that, initially, the rate of straw decomposition depends on how much nitrogen is available. Unexpectedly, however, decomposition soon becomes limited by lack of carbon. In the field, this should free the soil nitrogen for plant uptake."

Computer simulation of residue decomposition will be useful in studies of crop nutrient cycles and fertilizer needs under reduced tillage systems. Eventually, the group hopes to incorporate this mathematical model into a larger model that describes overall agricultural ecosystems.

Dr. Elliott's address is Room 215, Johnson Hall, Washington State University, Pullman, WA 99164. (By Lynn Yarris, SEA, Oakland, Calif. and Margaret Hunanian, SEA, Beltsville, Md.)

# Breakthrough for Hybrid Rice

New tall, simple-recessive rice plants may increase yields through hybrid vigor. (Photo courtesy Grant Heilman.)

Recent development of a simple recessive-tall rice plant has introduced a fourth significant element into what was a three-element system of obtaining hybrid cereal seed. With it, crop yields could be increased by combining hybrid vigor with the desirable agricultural trait of short stature.

The four genetic elements are incorporated into materials highly adapted to California, say developers J. Neil Rutger, SEA plant geneticist, University of California—Davis, and Howard L. Carnahan, director of plant breeding, California Cooperative Rice Research Foundation. Many crosses must then by made to find the few that have hybrid vigor.

Present hybridization of self-pollinated plants calls for three elements: cytoplasmic male sterility, a maintainer line, and a restorer line. Male sterility is necessary to allow breeders to fertilize plants with "selected" pollen only. The maintainer line retains the sterility, and the restorer line reestablishes the fertility that insures a seed crop for the grower.

The term *simple recessive* refers to a gene within the plant. When a male parent that is a simple recessive for tall is mated to a dominant short-statured plant, the resultant plants are short statured.

Short stature is a highly desirable characteristic in rice. It was introduced into California in the late 1970's by SEA, the California Cooperative Rice Research Foundation, and the University of California. The shortness in the stalks strengthens them enough to prevent lodging (bending over), which can reduce yield.

The actual development of rice hybrids for field use has been slow. The successful hybridization of rice, wheat, and other self-pollinated cereals has been limited by their pollen dispersal mechanisms, which may provide too little pollen to insure economic production of hybrid seed.

In the future, hybrid seed producers may be able to plant the recessive tall with the restorer gene in separate rows next to the female parents. Sufficient pollen dispersal could then maximize the production of the hybrid seed, yielding the short plants.

The recessive-tall rice grows about 10 inches above the shorter plants. After the tall plants accomplish their job of pollinating, their seeds are harvested separately so that they do not contaminate the hybrid lot with non-hybrid seeds.

The development of the recessive tall may introduce the element into hybrid production of wheat and other self-pollinated cereals. However, in announcing the recent discovery, Rutger and Carnahan have carefully pointed out that "it will be several years before hybrid rice will become a commercial reality in California." While research on rice hybridization continues, Rutger and Carnahan foresee future improvements in rice varieties by the more conventional breeding methods.

Dr. J. Neil Rutger is located at the University of California, Rm. 215 Hunt Hall, Davis, CA 85616.

 (Continued from page 2.)

University for his masters and doctorate. His dream of becoming a farmer was gradually being supplanted by new interests.

After Rutgers, Burton joined USDA as a research geneticist in Tifton, Ga.

**"There was free range when I arrived in Tifton, but fence laws were instituted quite soon. These cattle that had been roaming wild in the woods at no cost to the owners so far as forage was concerned now had to be supplied with feed inside the fence."**

This became his challenge.

Burton began working with bermudagrass for forage in 1936. Cotton was still king in the South, and bermudagrass was considered a pesky weed—the worst weed to plague cotton growers. **"I soon learned that you better not talk about bermudagrass to these people. They had a mule and a plow to fight it in the cotton fields. If they didn't keep at it, bermuda won out."**

Burton's first hybrid bermuda, a cross between a local bermuda and one from South Africa, was officially released in 1943 under the name Coastal. It produced almost no seed and had to be planted by sprigs. **"Of course we started out by just giving a bag of it to anyone who wanted it. We didn't have much of a market to begin with."** It was followed with a second hybrid, Coastcross, more readily digested by cattle. Today Burton's bermudas are grown on 10 million acres across the South as pasture and hay for beef cattle and other livestock.

These hybrid bermudas increased U.S. liveweight beef production by at least 1 billion pounds. Coastcross allows farmers to produce 30 to 40 more pounds of beef per acre. An even newer variety released in 1978 should produce 50 more pounds of beef per acre each year. By 1982 Coastcross could be planted on 1 million acres and could add 50 million pounds of beef at no extra cost.

Tifton-44 is the most recently bred bermuda and has more cold tolerance than those now being grown. It will push bermuda forages 50 to 100 miles

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Above: Gallon cans of pearl millet from 430 introductions are kept in cold storage by Burton. Here, he packages pearl millet seeds for shipping to a plant breeder, who will screen for resistance to a new disease (0975X1919-26).

Left: Burton checks a seed head of pearl millet before harvest. The seed head has been covered to prevent cross-pollination, and its seeds will be used in future breeding experiments (0975X1974-20).

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AGR-101

## Glenn Burton— The Scientist, *The Man*

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farther north. Burton found one of the parents of Tifton-44 growing in a small patch along the tracks of a railroad siding in Berlin, Germany.

Other Burton bermudagrass hybrids grow on golf courses, football fields, and lawns throughout the South, the Carribean, and Hawaii.

News of Burton's work soon spread beyond the borders of the United States. Cuba, using grass stolons imported from Jamaica, now grows Coastcross on half-a-million acres of land. The Cubans graze their dairy cattle on Coastcross because it produces more milk per acre than other grasses.

In 1974, as part of a U.S. scientific team visiting The People's Republic of China, Burton advised the Chinese to plant Coastcross along streams and on nearby hills around silt-filled irrigation reservoirs. In 1980, a colleague returning from China reported acre after acre of Burton's bermudagrass growing on hills and along irrigation channels.

Burton is now working with scientists at Karnal, India, to help them qrow Coastal and Coastcross bermudas on land abandoned because of too much salt in the soil to farm profitably. Bermudagrass, particularly Coastal and Coastcross hybrids, tolerates salty soils much better than many other plants. Burton says that the bermudas will make an excellent forage for dairy cattle on much of that abandoned land.

In addition to his forage grasses, Burton has created new pearl millet hybrids that help feed millions of people around the world. Millet is an annual grass resembling sorghum that grows well in hot, dry areas. Its spike-like heads bear seeds that are ground and made into porridge or a gray-colored flat bread. Millet grain is richer in protein and contains a better balance of amino acids than either corn or sorghum.

Not only does millet provide grain for food, but the stalks are used for fuel, fences, and framing for mud huts in the very arid sections of Africa, India, and Pakistan.

Because most grasses, including grains like millet, self-pollinate, creating hybrids was difficult. Burton altered pearl millet's cytoplasm to create the cytoplasmic male-sterile plants that made hybrids possible. This led to a worldwide increase in millet production.

Pearl millet now grows on 40 million acres worldwide, 27 million in India alone. In the United States, it is primarily used as a summer forage for cattle and hogs.

In 1961, Burton sent his cytoplasmic male-sterile millet seeds to India for use in their breeding programs. By 1965, Indian scientists had developed from Burton's seeds a new hybrid that yielded 88 percent more grain than common millet. **"That was the biggest thrill I ever had. In 1965, India produced 3.5 million metric tons and in 1970, just 5 years later, they produced 8 million metric tons—more than double."** In the United States, Burton's hybrid gives 50 percent more forage than common cattail millet.

Burton is now working with plant breeders from Mali and officials of Ciba-Geigy's philanthropic arm to develop better millet hybrids to feed this poor West African country. There, people eat the less tasty gero millet until their preferred maiwa millet can be harvested. Maiwa doesn't ripen until November because its flowering is triggered by short-day length.

Burton has discovered a gene, however, that would make pearl millet flower earlier and possibly produce seed 20 days sooner. Crosses are now being made in a Paris greenhouse between this genetically new millet and maiwa. If successful, the new hybrid will be planted in Mali for further tests.

Burton is also a member of an international multidisciplinary team of scientists investigating the fertility barriers to "wide crosses" in agricultural crops—like trying to breed a lion and a cat. Although the research is on the frontiers of science, it might be possible to create whole new groups of hybrids, each with a full range of characteristics—disease, drought, heat, or cold resistance—a plant breeder's dream.

**"I have always been interested in people and in trying to make a better world in which to live. My work has been my hobby, my joy. It has captivated my interest and crystallized the direction of my life—along with the realization that we can make a difference in the world. We have some responsibility as our brother's keeper."**